Multiple-track ant body attribute extraction method improved

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***Abstract*—to interpret small faults is always the core question for seismic exploration. Seismic attributes can help us understand the fault and fracture system better. The earthquake frequency controls seismic resolution, if the resolution is relatively low, minor faults or micro-fractures portrayed through the property body may not match reality. High frequency means high resolution, easier to distinguish small faults. In order to identify the fault better, we make a simple raw data processing to extract the high frequency part of the seismic. While using seismic attribute technology, improved ant-tracking method introduced into the three-dimensional data volume of the work , area structure will be explained. Because of its differentiating attributes extraction and analysis ability ant-tracking has a strong indicative of faults.**

Keywords*—small faults; fracture system; frequency;multiple-track

I. Introduction

For structural interpretation, the property has been acting as the auxiliary role of conventional interpretation. Ant-body, as an attribute interpretation of small faults recognition, is very effective. However, conventional seismic data, due to noise generated during acquisition and processing as well as phase axis lateral heterogeneity caused by lithology changes itself, has obvious signs of ant bodies horizon, fault lines often look messy. For this reason, many people think the ant-body is not as effective as the variance body[1]. In fact, there is very likely on nobody grasping the essence of the ant. Wrong or poor extraction methods, not only will lead to structural features not subtle, but also might generate a lot of false appearances, misleading interpreter. Previous researchers apply single track, our study uses high-frequency seismic data, multi-ant track, combined with the actual work area information, the appropriate intermediate processes supplemented (reasonable parameter settings) to give effect to construct better-display and better-quality ant-body[2].

II. Theory and Method

A. Theory

1) Structural Smooth

Smooth structure (Structural Smooth): the purpose is to remove the original random noise in seismic data, which can enhance the continuity of the seismic events, while the other parts of the boundary faults are well preserved.

2)Variance body

Variance body mainly reflects the space differences of seismic adjacent traces, when it comes to the existence of underground faults or a local regional stratigraphic discontinuous changes, some of seismic channel reflection characteristics will differ from the reflection features of seismic traces nearby, resulting in Local discontinuities in the seismic trace[3]. This discontinuity manifested in variance calculation algorithm model is high variance value, showing anomalies as high variance in the time slice or horizon slice of the body, through the variance discontinuous change information, you can identify the fault and other geological anomaly structure. The worse the lateral continuity of seismic waves is, higher the variance is, the more easily mutational abnormal points, caused by fault and geological anomalies, are reflected.

3) 3D Edge Enhancement

The purpose of border enhancement is to further improve continuity and separation of different signals, will make subsequent fault extraction more accurate[4]. Ant-tracking itself is a body created to enhance the properties of the edge, can be used again as an input to produce another ant-tracking body. Boundary enhancement technology will make the results more continuous, precise, high signal to noise ratio. One kind of body attribute filter has proved that this edge enhancement technique is applicable to any surface / fault / unconformity.

4) Frequency processing

Conventional post-stack seismic data is an imaging of seismic data of its entire frequency range, but main frequency and signal to noise ratio of seismic data is low, it is difficult to achieve the subtle interpretation about structure, using conventional methods[5]. In the seismic interpretation, different frequency response of the same fault is different, different frequency response for faults of different sizes are different. Using frequency processing can eliminate interference between different frequency components of the time domain, the interpretation results can be better, higher resolution, finer geological image.

5) Ant body

Ant-tracking is an analog of foraging behavior of ants in nature, mainly through information transfer between smart groups of artificial ants called to achieve optimization purposes [6]. In this process, the ants are always partial to a path where pheromone is concentrated; through constantly updated information eventually converge on the optimal path. In seismic exploration, seismic data volume or discontinuities (coherent body, variance cube) is spreading a lot of electronic ant, and set satisfied conditions to lead a single ant along the trace, at the same time release pheromones to attract other ants and turn down the track, when the track is stopped until the conditions are not met.

6) Tracking repeatedly

Ant-tracking is divided into three modes: Passive ant-tracking is a conservative estimate fault method along the signal-stronger direction, more effective for large regional fault type. Aggressive ant-tracking allow ants to detect faults in a more flexible way that can detect major faults, also more effective to small faults, small cracks. As for multi-tracking, such as triple-run, namely passive ant tracking - aggressive ant tracking – passive ant tracking (or aggressive ant tracking – passive ant tracking - aggressive ant tracking) tracks three times. At the first, passive ant tracking tracks the large regional fault type. Next, on the basis of the area faults from passive ant tracking, aggressive ant-trucking tracks finer small faults, cracks. Finally, getting aggressive ant track results as a new basis, according to small faults, fractures tracked, modify area large fault from the first-time negative ant tracking result, conduct passive ant tracking again. As a result, three-times tracking gradually converges to the optimal combination of fault, faults of different size confirm each other, so we can get more reliable interpretation results.

B. Methods

1) The traditional ant body attributes extraction method

Traditional ant Tracking Workflow:

a)Condition original seismic data. Use Structural smoothing with the Fault edge preservation option.

b)Edge detection. Generate a Variance or Chaos cube from Structural smoothing.

c)Generate an Ant-tracking cube from Variance or Chaos.

2) Frequency processing multiple-track ant body attributes extraction method

Ants Tracking Workflow Improvements:

a)Condition original seismic data. Use Structural smoothing with the Fault edge preservation option.

b)Frequency processing. Generate a relatively high-frequency cube

c)Edge detection. Generate a Variance or Chaos cube from Structural smoothing.

d)Edge enhancement. Generate a 3d edge enhancement cube from Variance or Chaos.

e)Ant tracking. Generate an Ant-tracking cube from 3d edge enhancement.

f)Triple-run ant tracking

triple-run (passive ant tracking - aggressive ant tracking - passive ant tracking) .

III. EXAMPLES.

Application results in different frequency bands data volume Sections were extracted from the different body data:

When the band is 0-50Hz (Fig.1.1), seismic resolution is low, high signal to noise ratio, breakpoints of large-scale fault are clearer. The faults are more continuous with higher reliability.

When the band is 50-100Hz (Fig.1.2), high seismic resolution, small-scale faults are well developed, breakpoints of small-scale faults in shallow become clearer; with no reliability, breakpoints of large scale fault in deep blur.

On the basis of the data volume, the ant body attribute slices were extracted.

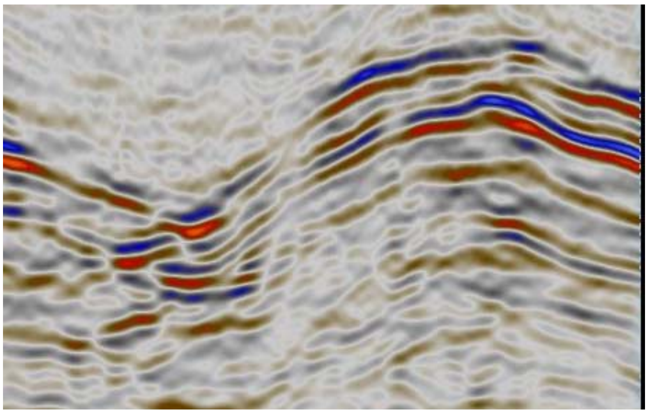

Fig.1.1 inline 400 seismic section of the band 0-50hz

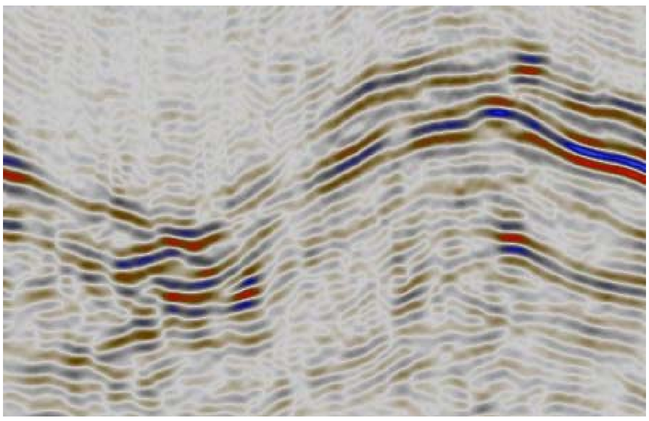

Fig.1.2 inline400 section of the band 50-100hz

Ant attribute volume slices of 0-50 hz band (Fig.1.3), the fault lines are sparse, continuing a longer length, the faults of large scale have mainly shown.

With the scale reducing, ant property body in the band of 0-50 hz does not recognize some small fracture, small-scale faults or lower order faults. But in small-scale ant tracking results, in Figure 1.4, a clear reaction comes out.

Because of 50-100 hz band data body's better resolution, the variance body attributes are extracted.

Fig.2.1 dark gray lines represent abnormalities faults reflected are vague, broken overlapping relationship is not clear. Horizon marks are quite obvious, is not conducive to identify fracture abnormalities. Moreover, the very high variance values are discrete punctate distribution, without reflecting the extension condition of continuous faults more directly. In Fig.2.1, only small faults in the section show deflection phenomenon, difficult to identify. In Fig.2.2, in the 3d edge enhancement section, the horizon marks show a substantial reduction, the fault contours show like legible lines, overlapping relationship between fault also becomes clearer.

Due to 3d edge enhancement structure's better reflection, on its basis, ant-tracking has been done.

Fig.1.3 Ant attribute volume section of 0-50hz band of inline430

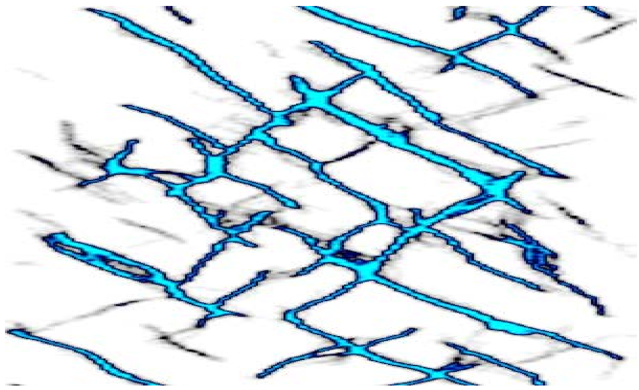

Fig.1.4 Ant attribute volume section of 50-100hz band of inline430

As shown in Fig.3.1, it can be seen from passive ant-trucking slices that work area structure is complex, the sizes of the fault are intricate. However, most faults intertwine with near faults, and breakpoints are fuzzy, is not conducive to the pickup of details (although not exclude the presence of Y-faults, but in most cases, not interwoven between each other). For fault line color shades similar, it is unlikely having large discrimination to indicate faults of different sequences reflected from slice. Fig.3.2, the passive ant-trucking - aggressive ant-trucking slice ， the details of the small fault and the small faults have demonstrated which is not reflected on a single ant-tracking body time slice. Fault line color changed significantly, the ant-track trace color about reliable fault or the fault of large size is significantly darker than the less reliable or smaller faults, which phenomenon has not shown on the single ant-track sections, it illustrates that the effect of twice-track is better on side. As shown in Fig.3.3,passive ant-trucking- aggressive ant-trucking-passive ant-trucking triple-track ant-body time slice, comparing with the twice-track ant body time slice, we found that the two are very close on large faults interpretation and fault combinations. But in terms of the detail description, triple-run ant-tracking has shown better effect. Fault intersection area as shown in the box in Fig.3.2and Fig.3.3, the extension and combinations tomographic condition of faults is blurry in the twice-track ant body slice.

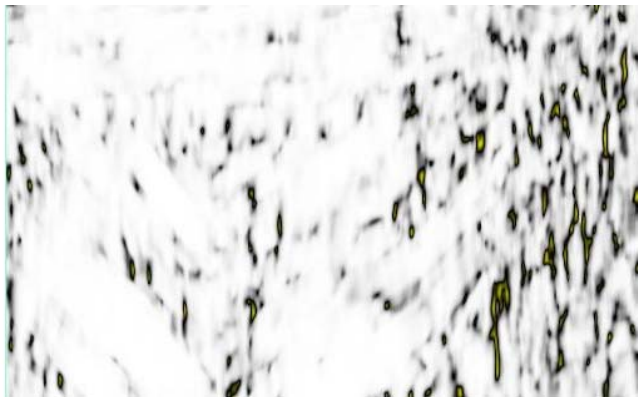

Fig.2.1 variance inverse section of xline300

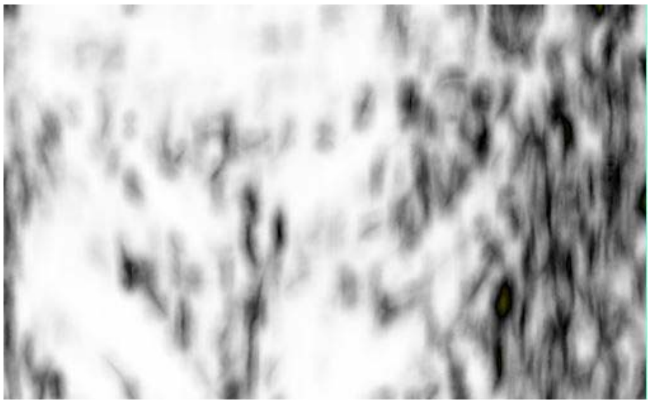

Fig.2.2 3D Edge Enhancement inverse section of xline300

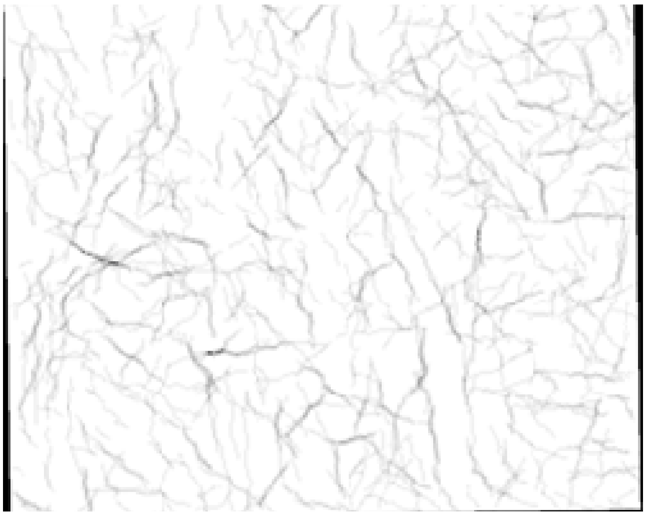

Fig.3.1 single-run ant-tracking time slice of -600ms

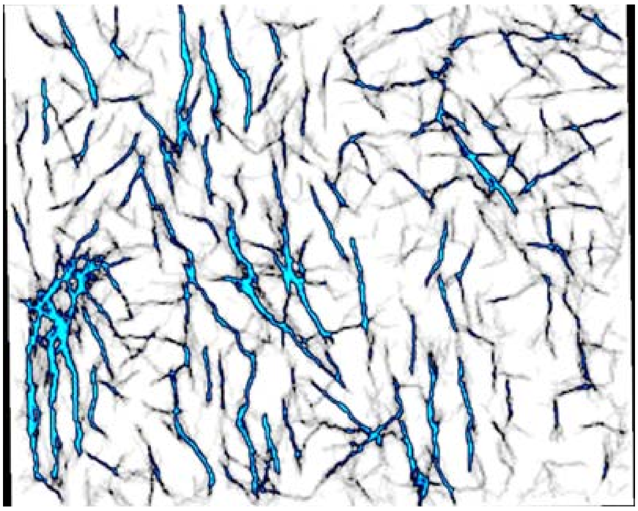

Fig.3.2 twice-run ant-tracking time slice of -600ms

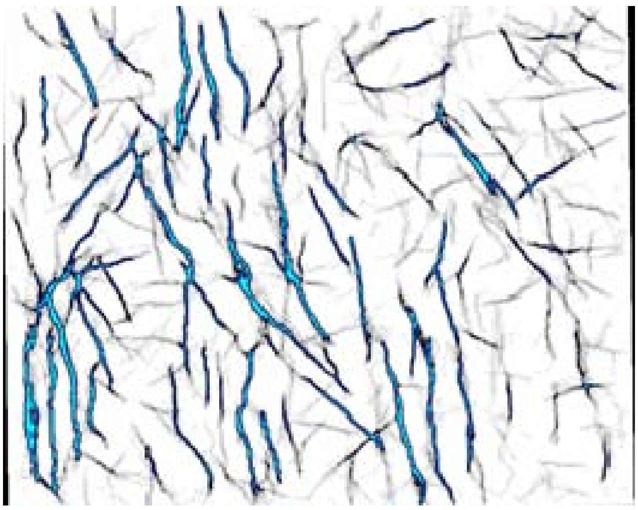

Fig.3.3 triple-run ant-tracking time slice of -600ms

Ant-track marks at the intersection of the lines is very confused, intertwined like lumps, is not conducive to study a combination of faults and a fine tracking of minor faults. And in the same area, triple-run ant-track property reflects the stratigraphic discontinuities more delicately. Faults details show clear, there is no confusion slug, small faults are tracked well. Tone shades of ant-track marks color shows closer relationship with reliability of fault lines, fault combinations and extension situation is clearer.

IV. CONCLUSIONS

In high-frequency data , small-scale faults are more apparent and clear. Due to the high-frequency extraction processing, the data volume will have increased resolution.

Compared with the variance body slice, slice through 3d edge enhancement can be more clear in the reaction of fault location and spatial distribution and orientation of cracks.

Single track ant body, some small faults and fault details are not reflected. On the twice-track time slice. Fault line color changes significantly, ant-track marks of reliable faults or the larger-size faults are darker than that of the lower-reliability faults or smaller ones. There is no phenomenon shown on a single ant-tracking slice before, which illustrates good effect of twice-track body. Triple-track ant body time slice, compared to the twice-track ant body time slice, triple-track has a better reflection of faults, more delicate. Faults details show clear, there is no mixed block mass. Ant-track marks tone shade has closer relationship with fault lines reliability, faults combination and extension is clearer.

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